The Structural Relation Between Mortgage and Market Interest Rates

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ABSTRACT

This paper analyzes the dynamic relationship between primary and secondary mortgage markets and the short-term and long-term market interest rates. Using a series of monthly data on fixed rate mortgage rates and GNMA rates, we explore the dependence and speed of adjustment in these primary and secondary mortgage rates to each other as well as to the long and short-term government rates. The results indicate that residential mortgage rates in general, appear to follow the long-term rate and are not very sensitive to movements in the short-term interest rate.

Keywords: mortgage rates, interest rates, Granger causality, vector autoregression, liquidity premium.

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1 INTRODUCTION

The valuation of mortgage-backed securities has been extensively examined in the literature. Beginning with the seminal work of Brennan and Schwartz (1979, 1982) on the pricing of bonds, many other authors such as Dunn and McConnell (1981a,b), Brennan and Schwartz (1985), Green and Shoven (1986), Ramaswamy and Sundaresan (1986) and Schwartz and Torous (1989, 1992) have advanced models for the pricing of interest-rate sensitive mortgage-backed securities.

There is a distinctly different but parallel body of literature which examines the behavior and characteristics of the underlying residential and commercial mortgages. However, unlike commercial mortgages, which have been studied by Kau (1987), Titman and Torous (1989) , Hannan and Liang (1995) and Benjamin, Heuson and Sirmans (1995) among others, the behavior and pricing of residential mortgages have received far less attention in the academic literature. This may in part be due to the fragmented nature of the residential mortgage market, as well as the recent increase in both mortgage securitization and refinancing of residential mortgages.

In an attempt to fill this void, we conduct an analysis of the dynamic relation between the primary and secondary residential mortgage rates and their relationship to the short-term and long-term interest rates. We focus our attention on the inter-relationships among the various mortgage rates and market interest rates as well as on the direction of causality between them. Specifically, using a series of monthly data on fixed rate conventional mortgages and another on GNMA mortgage rates, we examine the dependence and the speed of adjustment in these mortgage rates relative to short and long term interest rates.

The conventional mortgage market continues to offer both fixed and adjustable rate mortgages. The adjustable mortgage rate is reset periodically to reflect changes in the general interest rates. The barometer for interest rate changes is usually some index, either the one-year constant-maturity treasury rate, a federal home bank board district cost of funds rate, or the London inter-bank offer rate (LIBOR). It is important to note that while these indices are cited by most banks as the ones they use in adjusting their mortgage rates, there is no unanimity among banks regarding this adjustment procedure.

In recent years, approximately 50% of the residential mortgages originated in the United States have been securitized. Most of these are pass-through securities that are guaranteed, for a fee, by the Government National Mortgage Association (GNMA), or by one of the two government-sponsored enterprises; the Federal National Mortgage Association (FNMA) and the Federal Home Loan Mortgage Corporation (FHLMC). To qualify for an agency guarantee, the loan must be conforming to certain size and quality standards.

The Federal Reserve's decision to change the short-term interest rates often reverberates into the longer-term markets and quickly impacts residential and commercial mortgage markets. Moreover, the home building sector, which is highly sensitive to interest rate swings, is significantly impacted as interest rate hikes are generally reflected in higher overall mortgage rates.

To study the dynamic relation between residential mortgage rates and market interest rates, we posit the following questions; How are changes in mortgage rates impacted by changes in the short-term and long-term market rates? How long does it take for mortgage rates to fully adjust to changes in interest rates? How large is the premium in the conventional rate mortgage over the GNMA mortgage rate? These and other related questions are examined using Granger causality, regression analysis and vector autoregression (VAR) methods.

This paper is organized in five sections. Section 2 discusses the data and presents summary statistics for all of the series examined. Correlation and autocorrelations results among the variables are also presented. Section 3 provides Granger causality tests between mortgage rates and both short-term and long-term interest rates. Section 4 presents the VAR results along with the related impulse response functions. The final section provides a brief summary and some concluding remarks.

2 DATA

The data used in this study is obtained from the Wall Street Journal and the Federal Reserve Board of Governors homepage. We use monthly data for the period January 1989 to December 1996 for 30 year FNMA, GNMA, FHLMC mortgage securities and conventional mortgages. The proxy for the short term rate is the three month t-bill rate and for the long term, the ten-year government bond rate. Table 1 provides descriptive statistics on the variables used while Table 2 shows the correlations between these variables. The nearly perfect correlation between the FNMA, GNMA and FHLMC rates suggest that using all three variables might prove redundant, thus we focus only on GNMA data. Conventional mortgages however, have somewhat different characteristics. For example, its mean and standard deviation are higher than the GNMA rates. Liquidity premium is calculated as the difference between conventional rate and the GNMA rate. Term premium is the difference between the long term rate and the short term rate on government securities and represents the slope of the yield curve.

Table 1 and 2 to go here.

The liquidity premium variable is incorporated to examine whether there is a systematic difference between the behavior of the rates on conventional mortgages and those of the more liquid GNMA rates. Furthermore, it is important to understand how this liquidity premium might change over the business cycle. The term premium variable is incorporated to study the reaction of the mortgage rates to the short and long term interest rates during recessionary time periods as well as during times of economic expansions. It has been suggested that mortgage rates respond faster to rising than declining interest rates.[1]

(i) Unit Root Test

To check for stationarity in the variables, we performed the following Augmented Dickey-Fuller unit root test.

$$\Delta x_t = \alpha + \beta x_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta x_{t-j} + u_t$$

where Δ is the difference operator, u_t is white noise, p is the optimal lag in the autoregressive representation of x_t. If the autoregressive representation of x_t contains a unit root, the t-ratio for the parameter β should be consistent with the hypothesis $\beta = 0$. Since the conventional t tables are inappropriate for this hypothesis test, Dickey and Fuller (1979) and Fuller (1976) results have been used to interpret the t-ratio.[2]

According to the unit root test results, the rates on GNMA, conventional mortgage, t-bills and bonds are all non-stationary in levels but are first difference stationary. Liquidity and term premium are stationary in levels. Table 3 shows the 12 lag autocorrelations of GNMA rates, conventional mortgage rates, t-bills, bonds, liquidity premium and the term premium. The gradual decay in autocorrelations of GNMA, conventional rate, t-bills and bonds suggests the potential presence of an integrated component.

Table 3 to go here.

Table 4 provides estimates for the contemporaneous relation between changes in long term and short term interest rates versus changes in the mortgage rates. The first difference of mortgage rates is regressed on the first difference of the t-bill rate and the bond rate. Changes in GNMA mortgage rates exhibit a significant positive relation with changes in the ten-year long term bond rate, but are not significantly related to changes in the short term t-bill rate. On the other hand, changes in the conventional mortgage rates are significantly related to both changes in the short term and the long term rates. This result may be due to the fact that the conventional mortgage rate is a composite average of many mortgage lenders. It reflects how lenders on average adjust to changes in interest rate fluctuations.

Table 4 to go here.

Another important result emerges from the regressions in Table 4. When the variables liquidity and term premium are incorporated into the regressions, the R^2 increases from 37% to 55% for the GNMA regression. There is clearly no such effect on the conventional mortgage regression. More interestingly, the liquidity premium coefficient of 0.48 confirms the common belief that the increased liquidity of the GNMA securities often allows these rates to be 50 basis points below other mortgage rates. This result is consistent with Schwartz and Van Order (1988).

3 GRANGER CAUSALITY TESTS

To examine whether the mortgage rates are caused by short term rates and/or long term rates, we conduct a Granger causality test where a variable x is said to cause another variable y if current values of y can be predicted better by using past values of x than by not using them. Consider the representation:

$$y_t = \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \cdots + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \cdots + u_t$$

x Granger causes y or x helps predict y if $\beta_i \neq 0$ for some i. Since all our variables were shown earlier to exhibit first difference-stationary behavior, we use the rates of change of these variables to conduct the Granger causality tests.

Panel A of Table 5 shows the regression of mortgage rates on t-bill rates. The lagged coefficients of t-bill rates are shown to Granger cause GNMA rates but are found not to Granger cause conventional mortgage rates. By examining the results in Tables 4 and 5, it is clear that although there is no contemporaneous relation between GNMA and t-bill rates, the lagged values of t-bills do Granger cause GNMA rates. On the other hand, the conventional rates have significant relation with contemporaneous t-bill rates but do not exhibit a causality effect from t-bill rates.

Table 5 to go here.

Panel B of Table 5 shows the regression of mortgage rates on long term bond rates. The one month lagged coefficients of bond rates show a significant causality relation with mortgage rates. In the case of both GNMA and conventional mortgages, the one month lagged bond rates had a significant positive impact on mortgage rates. However, the two month lagged bond rate coefficient is not statistically significant and thus has no impact on the GNMA and conventional mortgage rates. This implies that the mortgage rates adjust to changes in bond rates within one month period.

The results in Table 5 are consistent with the initial regression results presented in Table 4. GNMA rates are influenced by lagged rather than contemporaneous t-bill rates. The contemporaneous bond rate and the one month lagged bond rate are both positively related to the GNMA rate. Conventional rates are also affected by bond rates in the same manner. The t-bills on the other hand, do not Granger cause conventional rates like GNMA rates. Specifically the long term rate appears to be far more influential in determining the rates on conventional mortgages.

4 VECTOR AUTOREGRESSION

Vector autoregression determines patterns in variables by estimating a system of equations in which each variable is related to the past values of itself and all the other variables in the system. In the general case,

$$\mathbf{y_t} = \mu + \rho_\mathbf{1}\mathbf{y_{t-1}} + \cdots + \rho_\mathbf{p}\mathbf{y_{t-p}} + \mathbf{v_t} + \theta_\mathbf{1}\mathbf{v_{t-1}} + \cdots + \theta_\mathbf{q}\mathbf{v_{t-q}}$$

where $\mathbf{y_t}$ and $\mathbf{v_t}$ are vectors of random variables, μ is the mean vector, ρ_1**, ...,** ρ_p**,** θ_1 **, ...,** θ_p are the parameter matrices. This representation produces a vector ARMA model. For most applications, including this study, the VAR is based on simpler models without moving average terms. The resulting model that we estimate is:

$$\mathbf{y_t} = \mu + \rho_1 \mathbf{y_{t-1}} + \cdots + \rho_p \mathbf{y_{t-p}} + \mathbf{v_t}$$

where $\mathbf{y_t}$ is a vector autoregression representing GNMA and conventional mortgage rates respectively.

The quality of the forecast depends on the choice of the variables. The number of variables and the number of lags cannot be arbitrarily increased to improve the accuracy of the forecasts. Estimating too many coefficients with limited amount of data can cause occasional past deviations from the fundamental pattern to be incorporated into the estimates of the coefficients. In order to avoid past one time deviations and capture the true fundamental pattern, the number of variables and number of lags should be carefully modeled. It is important to note that all of the variables used in the VAR are shown to exhibit difference-stationary behavior and are not cointegrated.[3] Table 6 shows the VAR(1) estimation results of the conventional and GNMA rates. In the presence of both the short term and the long term rates, the effect of short term rates on the mortgage rates is minimal. This result is not surprising given that the long term and mortgage rates have similar characteristics.

Table 6 to go here.

The top part of Figure 1 shows the impulse response function of GNMA rates to innovations in GNMA rates, long term bond rates and t-bill rates. The impulse response function traces the dynamic effects of shocks in the short and long term interest rates on future GNMA rates. The impulse response function shows that the innovations in bonds rates have more influence in affecting GNMA rates than the innovations in t-bill rates. The gradual decay of the response function indicates that GNMA rates take 4 to 6 months to completely adjust to the changes in short term and long term interest rates.

Figure 1 to go here.

The bottom part of Figure 1 depicts the impulse response function for conventional mortgage rates to innovations in the conventional rates, long term bond rates and three months t-bill rates. The innovations in bond rates have a much more significant effect on future conventional rates than on future GNMA rates. The innovations in t-bills have very similar effect on both GNMA and conventional mortgage rates. The conventional mortgages rates are shown to take up to 6 months to adjust to innovations in short term and long term interest rates. Figures 2 and 3 show the standard error bands for the impulse response functions for the conventional and the GNMA rates respectively. It is important to note once again how the conventional rate is be far less impacted by innovations in the t-bill rate than the GNMA rate.

Figure 2 and 3 to go here.

Table 7 shows the variance decomposition of GNMA rate and the conventional mortgage rate. The following variance decomposition gives information on the relative contribution of structural disturbances in the mortgage rates, short term rates and long term rates to the variance of the forecast error in the endogenous variables. The endogenous variable being the GNMA rate in Panel A, and the conventional mortgage rate in Panel B of Table 7.

Table 7 to go here.

It is widely noted that variance decompositions are sensitive to the ordering of the VAR variables (Bomfim (1997)). In our analysis, we have placed bonds last, an assumption that potentially works against the hypothesis that it is important in explaining the variance in the endogenous variable. The results show that the mortgage rate shocks explain most of the variation in the mortgage rates at all forecasting horizons. However, the long term bonds, even though placed last in the VAR ordering, contribute more in explaining the fluctuations in the mortgage rates than the short term rates. The innovations in the short term rates do not have any significant effect on conventional mortgage rates. Note that conventional mortgages are driven by innovations in the bond rates much more than the GNMA mortgages. Finally, the VAR results are shown to provide further support to the Granger causality results that the long term rates have more significant relation with the mortgage rates than the short term rates.

5 SUMMARY AND CONCLUSIONS

This paper examined the structural relationships among GNMA and conventional mortgage rates and the long and the short term interest rates. In addition to regression analysis, we utilized unit root tests, Granger causality tests and vector autoregression techniques to study the inter-relationships among the variables.

Several important conclusions emerge. Perhaps the most important finding of this study is that mortgage rates as measured by the GNMA rates and the conventional mortgage rates are shown to closely follow the long term interest rates as represented by the 10 year Government bond rate. More importantly, changes in the short-term rates had little or no direct effect on mortgage rates.

Estimating a vector autoregression allowed us to examine the speed of adjustment in the mortgage rates to changes in market interest rates. Impulse response functions showed that any changes in the long-term interest rate is completely reflected on both the conventional and the GNMA rates within a period of one month. The dependence of the mortgage rates on changes in the long-term rates alone may have important implications regarding the stability of rates in the secondary mortgage market which represents a unique investment vehicle for institutional investors.

Another interesting finding relates to the expected higher liquidity premium afforded to the GNMA rates relative to the conventional mortgage rates. It is shown that GNMA mortgages commanded a liquidity premium estimated in our regressions to be 0.48. This estimated premium could be interpreted to reflect approximately a 50 basis point premium over conventional mortgage rates. The added marketability, standardization and perhaps even the guarantees that are enjoyed by GNMA mortgage rates over conventional mortgage rates, give rise to this liquidity premium.

NOTES

1 The term premium has been shown to predict business cycles. Stock and Watson (1989, 1990a,b, 1993) have found that the slope of the yield curve is one of the two most potent leading variables for predicting business cycles. Chen (1989) and Harvey (1989) have shown that the slope of the yield curve contains additional and independent information that enhances the predictability of the future levels of real economic activity. More recently, Lahiri and Wang (1996) find that the slope of the yield curve outperformed all other variables in predicting turning points in business cycles.

2 The Augmented Dickey Fuller test results are available from the authors.

3 If the variables used to estimate the VAR are cointegrated, then one needs to estimate an error correction VAR as opposed to the unrestricted VAR estimation that we used in this section.

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Table 1

Summary statistics for FNMA, GNMA, FHLMC and conventional mortgage rates, the long-term 10 year bond rate and the 3 month t-bill rate. Liquidity premium is the difference between conventional rate and the GNMA rate. Term premium is the difference between the 10 year bond rate and the 3 month t-bill rate.

Variable	Mean	Std. Dev.	Max	Min
T-bills	5.32	1.85	8.83	2.85
Bonds	7.33	1.04	9.30	5.33
Conventional	8.82	1.13	11.05	6.83
GNMA	8.32	0.98	10.29	6.25
FHLMC	8.27	1.20	10.42	5.39
FNMA	8.26	1.23	10.45	5.27
Liquidity	0.45	0.29	1.11	-0.30
Term Premium	2.07	1.02	3.74	-0.12

Table 2

Pearson correlation coefficients among FNMA, GNMA, FHLMC and conventional mortgage rates, the long-term 10 year bond rate and the 3 month t-bill rate.

Variable	T-bills	Bonds	Conventional	GNMA	FHLMC	FNMA
T-bills	1	0.82	0.87	0.87	0.86	0.86
Bonds	0.82	1	0.97	0.97	0.96	0.96
Conventional	0.87	0.97	1	0.97	0.96	0.96
GNMA	0.87	0.97	0.97	1	0.99	0.99
FHLMC	0.86	0.96	0.96	0.99	1	0.99
FNMA	0.86	0.96	0.96	0.99	0.99	1

Table 3

Twelve month lag autocorrelations of GNMA, conventional mortgage, t-bills, bonds, liquidity premium and term premium.

Variable	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	ρ_9	ρ_{10}	ρ_{11}	ρ_{12}
GNMA	.94	.86	.78	.72	.68	.63	.59	.53	.48	.44	.41	.37
Convent	.96	.89	.83	.77	.72	.68	.64	.60	.55	.51	.46	.42
T-bills	.99	.96	.94	.91	.89	.85	.82	.78	.75	.71	.67	.63
Bonds	.93	.85	.79	.75	.69	.64	.59	.54	.49	.45	.43	.41
Liquidity	.62	.53	.52	.49	.44	.47	.48	.41	.40	.36	.34	.29
Term	.95	.89	.84	.79	.74	.67	.60	.53	.45	.37	.30	.23

Table 4

The first part of this table shows how changes in the three month t-bill rate and ten year bond rate affect changes in the conventional and GNMA mortgage rates. The second part shows the results with the two additional variables, liquidity and term premium. Δ represents the first difference. The numbers in parentheses are the t-statistic. An asterisk ($*$) indicates that the variable is significant at the 95$\%$ confidence level.

$$\Delta y_t = \alpha + \beta_1 \Delta Tbills + \beta_2 \Delta Bonds + \zeta_t$$

y_t	β_1	β_2	R^2
GNMA	0.02	0.67	0.37
	(0.17)	$(5.83)^*$	
Conventional	0.25	0.61	0.69
	$(3.17)^*$	$(9.72)^*$	

$$\Delta y_t = \alpha + \beta_1 \Delta Tbills + \beta_2 \Delta Bonds + \beta_3 liquidity + \beta_4 term + \eta_t$$

y_t	β_1	β_2	β_3	β_4	R^2
GNMA	-0.11	0.57	-0.48	-0.02	0.55
	(0.89)	$(5.62)^*$	$(5.55)^*$	(1.11)	
Conventional	0.26	0.61	0.03	0.01	0.69
	$(3.17)^*$	$(9.38)^*$	(0.53)	(0.64)	

Table 5

Panel A shows Granger causality tests between both GNMA and conventional mortgage rates and the three-month treasury bill rates whereas Panel B shows Granger causality tests between GNMA and conventional mortgage rates and the ten year bond rates. Δ is the difference operator. The numbers in parentheses are the t-statistic. An asterisk ($*$) indicates that the variable is significant at the 95$\%$ confidence level.

Panel A				
$\Delta y_t = \alpha + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \beta_3 \Delta Tbills_{t-1} + \beta_4 \Delta Tbills_{t-2} + \eta_t$				
y_t	β_1	β_2	β_3	β_4
GNMA	0.06	-0.05	0.40	-0.43
	(0.56)	(0.43)	$(1.99)^*$	$(2.36)^*$
Conventional	0.54	-0.25	0.06	-0.04
	$(4.34)^*$	$(2.03)^*$	(0.43)	(0.30)

Panel B				
$\Delta y_t = \alpha + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \beta_3 \Delta Bonds_{t-1} + \beta_4 \Delta Bonds_{t-2} + \epsilon_t$				
y_t	β_1	β_2	β_3	β_4
GNMA	-0.14	-0.26	0.51	-0.01
	(0.92)	(1.50)	$(2.59)^*$	(0.05)
Conventional	0.09	-0.26	0.45	0.08
	(0.53)	(1.72)	$(3.18)^*$	(0.57)

Table 6

VAR(1) estimation of GNMA mortgage rates, Conventional Mortgage rates against the three month t-bill rates and ten year bond rates. The numbers in parentheses are the t-statistic. An asterisk ($*$) indicates that the variable is significant at the 95$\%$ confidence level. The values of R^2, Adj R^2 and Akaike information criterion (AIC) is given in the last three columns respectively.

$$\Delta y_t = \alpha + \beta_1 \Delta y_{t-1} + \beta_2 \Delta Tbills_{t-1} + \beta_3 \Delta Bonds_{t-1} + \eta_t$$

y_t	α	β_1	β_2	β_3	R^2	Adj R^2	AIC
GNMA	-0.03	-0.04	0.01	0.28	0.05	0.02	6.68
	(1.00)	(0.29)	(0.06)	(1.65)			
Convent	-0.02	-0.03	-0.02	0.52	0.32	0.29	3.05
	(1.15)	(0.16)	(0.14)	$(3.74)^*$			

Table 7

Panel A shows the variance decomposition of GNMA mortgage rates. The variables explaining the variance are innovations in GNMA mortgage rates, t-bill rates and long term bond rates. Panel B shows the variance decomposition of Conventional mortgage rates. The variables explaining the variance are innovations in Conventional mortgage rates, t-bill rates and long term bond rates.

Panel A			
Period	Δ GNMA	Δ T-bills	Δ Bonds
1	100.00	0.00	0.00
2	97.51	0.45	2.03
3	97.53	0.46	2.00
4	97.49	0.46	2.03
5	97.49	0.46	2.04

Panel B			
Period	Δ Conventional	Δ T-bills	Δ Bonds
1	100.00	0.00	0.00
2	88.72	0.23	11.04
3	87.89	0.26	11.83
4	87.78	0.29	11.91
5	87.76	0.31	11.92